TiO_2 mediated heterogeneous photocatalytic degradation of moxifloxacin: operational variables study

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Fluoroquinolones(FQ) are a family of synthetic, broad-spectrum antibacterial compounds, used in a variety of human and veterinary applications. They have gained substantial popularity since their introduction in the 1980s. Consumed antibiotics are not fully metabolized in the body and are partially (> 50%) excreted in the pharmaceutically active form[1]. Due to the limited biodegradability and the widespread use of these antibiotics, large quantities are released in the environmentcausing adverse effects on aquatic organisms,e.g. quinolone resistance of bacteria[2]. In house experiments with AOPs like ozonation and sonolysis show that they are promising techniques for the degradation of these antibiotics in effluent waters[3, 4].
In this study, heterogeneous photocatalysis is used for the degradation of afourth generation fluoroquinolone moxifloxacin (MOX)in a lab-scale batch reactor of 0.3 L. The objective is to bring insights in the effect of different operational variables on the degradation kinetics of MOX. Recentlypublished work showed that the optimal working pH is pH 7 [5].The pH is therefore not further discussed and the focus lies on the effect of operational variables like catalyst concentration, inlet MOX concentration, temperatureand inlet oxygen partial pressureon theremoval kinetics of MOX.
Experimental data are evaluated with respect to partitioning ratios, half life times, pseudo-first order degradation constants and initial degradation rates.

Applying different catalyst loadings under two stirring regimes gave an optimal catalyst concentration of 5g TiO_2 L^{-1} but ashorter half life time was obtained under more vigorous stirring ($t_{1/2,\ rpm\ 1}$ = 1.8min; $t_{1/2,\ rpm\ 2}$ = 1.5min).
Increasing the inlet FQ concentration with a fixed catalyst mass of 5g L^{-1}resulted in a significant higher initial degradation rate up toan initial MOX concentration of60 $\mu molL^{-1}$, where stagnation appears.
Using a higher reaction temperature increased the initial degradation rate substantially up to 298K. Above this temperatureonly a small increase of the initial degradation rate could be observed.
Oxygen is necessary during MOXphotocatalysis reaction to inhibit the recombination of produced holes and electrons. A reaction performed under nitrogenspargingresulted in a significant retardation of the degradation reaction ($t_{1/2}$ = 6.00min) when compared to air sparging($t_{1/2,\ air}$ = 1.5 min). A small difference was noticed between oxygen and air spargingduring thephotocatalytic degradation of MOX ($t_{1/2,\ O2}$ = 1.7min) but nevertheless sparging is necessary, since no spargingwith the reactor in contact with the ambient atmosphere resulted into a longer degradation time ($t_{1/2,\ atmosphere}$ = 2.3min).

Half life times in this study for the degradation of 15 mg MOX L^{-1}ranged from 6.0min to 1.5min. This indicates that an optimalisation of working conditions is necessary for future applications ofheterogeneous photocatalysis towards FQ degradation.
Summarizing, in the reactor used, the fastest degradation for a concentration of 15 mg L^{-1} MOX is obtained at neutral pH, a catalyst loading of 5 g L^{-1} with a high stirring speed, a 298 K reaction temperature and air sparging($t_{1/2}$ = 1.5min).

Literature

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